SUBTEMPORAL DECOMPRESSION IN A CASE OF CHRONIC NEPHRITIS WITH UREMIA; WITH ESPECIAL CONSIDERATION OF THE NEURORETINAL LESION.

By Harvey Cushing, M.D.,

and

James Bordley, Jr., M.D.,

of Baltimore.

The patient, Mrs. B. S., aged twenty-two years, was admitted to Dr. Barker's service in the Johns Hopkins Hospital,[1] on July 24, 1907, complaining of headache and vomiting, pain in the joints, and swelling of the legs. Her father died with some obscure cardiac symptoms. . . . With the exception of chronic indigestion and "sick headaches," from which she has suffered off and on all her life, she has always regarded herself as reasonably well and strong, until her present illness. She had diphtheria when twelve years of age, but knows of no other infectious diseases. She was married a year ago; has never been pregnant. She has lived a very unhygienic life, standing at work in a factory for long hours, six days in the week.

The present illness is said to have begun abruptly, five weeks before her admission, with a persistent headache for which there was no determinable cause. (It is probable from her history of dyspepsia and headache that the trouble had been of long standing.) One week ago swelling of the feet was first noticed; she has had pains in her arms and legs for the past four days, and has been unable to retain anything on her stomach. Heretofore she has vomited occasionally, but only in association with her sick headaches.

On admission: the patient is a dark complexioned, young woman of slender build, and sparely nourished. Her buccal and conjunctival mucous membranes are pale. . . . The left pupil is slightly larger than the right. Both react normally to light and accommodation. . . . Both eyes are slightly prominent, the right more than the left; v. Graefe's and Joffroy's signs are positive; Stelwag's sign is absent. Convergence is a little weak in the right eye. The thyroid gland is not palpably enlarged. Her chest is fairly well formed; . . . respiration is clear without adventitious sounds. The point of maximum impulse of the heart is visible in the fifth interspace 7 cm. from the midsternal line. . . . Relative cardiac dulness . . . considerably increased. At the apex a rough blow, which is transmitted to the base and can be heard over the auricular area, follows the first sound. The aortic sound is ringing and amphoric; . . . the pulmonic second sound is greatly accentuated, and a soft systolic blow is heard over the pulmonic area. The radial pulse is 80, regular in force and rhythm; the vessel is palpable. Systolic pressure equals 175 mm. of Hg. The abdomen is negative. There is no enlargement of the liver. . . . There is no œdema of the extremities; the platellar reflex is equal on the two sides and very active. There is a leukocytosis of 14,800; the blood is otherwise negative. The urine is pale yellow in color; specific gravity, 1012; no sugar; a trace of albumin and flocculent sediment containing hyaline and granular casts. Albumin, 0.5 gram to the liter; urea, 12 grams to the liter. The subsequent twenty-four hour amounts varied from 510 to 1200 c.c.

---

[1] We wish to express our indebtedness to Prof. L. F. Barker for the privilege of using the notes here abstracted from the patient's medical history; to Dr. G. R. Henry, of the medical staff, for her careful record of the case and unflagging devotion to the patient; to Dr. W. G. MacCallum and Dr. Winternitz, of the pathological department, for the autopsy report and sections of the eyes; to Dr. Frederick H. Verhoeff, of the Massachusetts Charitable Eye and Ear Infirmary, for his aid in the study of the retinal lesion; and to Mr. Louis Brown, of the Massachusetts General Hospital, for the excellent photomicrographs of the sections.

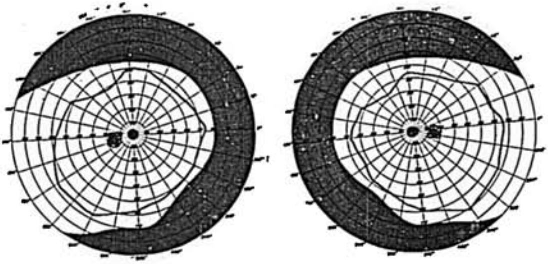
On July 27 the patient complained of pain in her right knee, which was held flexed and appeared swollen; . . . an accumulation of fluid in the joint associated with tenderness. . . . On the following day there was a similar complaint of discomfort in the left shoulder; . . . she had had recurring attacks of discomfort of this kind before her admission.

On July 30 she suffered from an exceedingly severe headache, moaning constantly, and occasionally crying out with pain. There was considerable mental confusion at times, . . . and periods of dulness during which it would be difficult to arouse her. . . Her systolic pressure registered above, 230 and the second aortic sound was extremely loud and ringing. A sweat bath was given, but this so disturbed her cardiac action that it had to be interrupted; . . . she perspired freely, however, and the measure seemed to give some relief.

Ophthalmoscopic Examination (Bordley). "Media are clear; pupillary reflexes are normal. There is a swelling of the right disk of 6 D., of the left of 7 D. The disks are very œdematous; the outlines are entirely lost; the physiological cup is filled in; the larger veins and arteries are seen dipping in and out of the extreme œdema both over the disk and adjoining retina. There are a great many small hemorrhages on the disk and on the retina near it. There is no stellate figure in the macula, and at this distance from the disk there is little swelling of the retina. The retinal picture of the two sides is practically the same." Vision = $\frac{20}{200}$ right eye; $\frac{10}{200}$ left eye. There is a concentric contraction of the field of vision with an enlarged blind spot (Figs. 1 and 2). Impossible to make color tests owing to patient's exhausted physical condition.

From this time on until October 24, the time of her operation the history may be condensed as follows (the notes are taken from numerous detailed observations made by Drs. Futcher, Emerson, Morris, Sladen, Beall, Henry, and others of the medical staff who had her under observation during these three months):

She continued in very much the same state described above, having occasional days of improvement, but for the most part suffering from severe headaches, nausea and vomiting, and other signs of pressure. The notes upon her cardiac condition did not vary greatly, although occasionally a diastolic murmur could be heard loudest at the apex and traceable as far as the anterior axillary line. The systolic murmur remained audible. A capillary pulse was occasionally observed in her finger nails. There was a more or less constant elevation of temperature during the first weeks after her admission, ranging from 100° to 103°. This occurred in association with the swelling of the joints, although at no time was there any evidence of a suppurative arthritis. By a month after her admission anasarca was quite marked. The face was considerably swollen.



FIGS. 1 and 2.—Visual fields charted July 30, 1907, showing slight constriction with enlarged blind spot.

During August she suffered greatly from pyorrhœa alveolaris, and at one time a dirty, grayish slough, starting from an ulceration of the gums, spread over the soft palate and inner surface of the right cheek. . . . Under energetic treatment this condition gradually improved.

She first began to complain of dimness of vision in September. (An ophthalmoscopic examination on September 13 is recorded as showing "intense albuminuric retinitis.") She seemed, however, subjectively somewhat improved, and early in October she was allowed for a few consecutive days to be out of bed and on her feet for some hours. . . . This resulted in accentuating her headaches and in producing marked swelling of her extremities, so that he again had to be kept recumbent. Subsequent to this there was a marked diminution in her visual cavity.

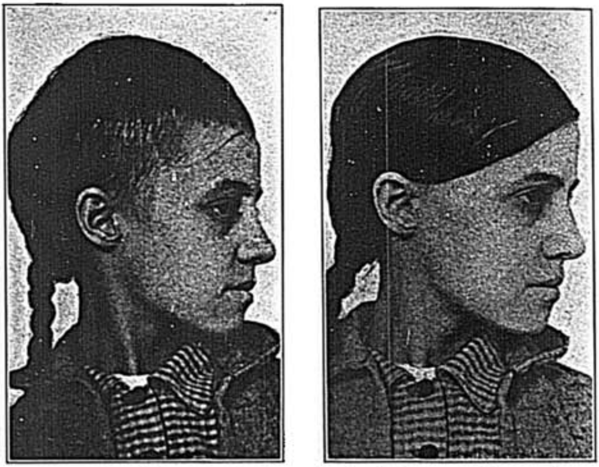
Ophthalmological Notes, October 11 (Bordley). "The palpebral orifices are wide. Slight exophthalmos of both eyes, probably more marked on the left. Upper lids definitely pigmented. Some slight fulness below the brows and loss of the associated movement of brow and superior rectus. No wrinkling of the brow. Involuntary spasmodic movement of upper lids when she looks upward. Upper lids at times are drawn above the corneæ sufficiently to expose the scleræ. There is loss of power of binocular convergence. The act of winking is incomplete, although not diminished in frequency. The lids close incompletely, and the effort brings out a marked tremor. It is difficult to evert the upper lids, particularly the right. The left pupil is slightly larger than the right; both of nearly normal size. The media are perfectly clear. The fundi present a peculiar appearance; the entire retina on both sides is so swollen that it is impossible to locate the disks. It requires a 5 D lens to see the surface of the retinæ distinctly. There remains no landmark by which the disk can be located. The whole surface of the retina is covered with hemorrhages of varying size and with tremendous yellowish white exudates. Two veins can be made out in each eye, but the other vessels are concealed. A careful search over the entire surface of both retinæ fails to disclose any signs of an artery. The picture is a most unusual one, and the changes since July 30 are astounding."

Later in October her symptoms became much aggravated, and definite signs of uremia appeared. A number of lumbar punctures were made during this period, in the hope of relieving some of her severe pressure symptoms. Fluid was always found under great tension, but its removal seemed to give no subjective or objective evidence of benefit—in fact, it usually had a temporary disturbing effect.

On frequent examinations the urine showed very little change from the condition noted at the time of her entrance. . . . The blood pressure remained high, its systolic level averaging from 200 to 250 mm., the diastolic level from 170 to 190 mm. Neither the lumbar punctures, nitroglycerin, nor other measures which had been tried had had any appreciable effect in lowering her high tension pulse.

In the light of some experiences in other renal cases in which notable temporary improvement in the general symptoms, as well as in the condition of the eyes, had occurred after lumbar puncture, we were led to suggest—owing not only to the advancing change in the eye-grounds, but also to her condition of semicoma—the propriety of a decompressive operation, and the patient was transferred to the surgical side for this purpose.

Operation, October 24, 1907. *Right Subtemporal Decompressive Craniectomy.* Under chloroform anesthesia, with a curvilinear skin incision, the usual circular cranial defect with opening of the dura was made under the right temporal muscle (Figs. 3 and 4). Owing to the fact that there was a large temporal muscle which could be readily elevated after splitting its fibers, the removal of bone was easily accomplished. The only difficulty which was experienced lay in the unusual degree of bleeding from all of the tissues, scalp, muscles, and particularly from the surface of the dura. The veins were considerably congested, and the arteries encountered were markedly tortuous and sclerotic. The dura was exceedingly tense, and, owing to the marked degree of cerebral protrusion which followed the first incision, it was opened with some hesitation in the absence of a coincident lumbar puncture. It was accomplished, however, without injury to the pia arachnoid. The subdural space contained no free fluid. The arachnoid, on the other hand, was markedly distended with fluid, which escaped after pricking the membrane in a number of non-vascular spaces where it bridged the exposed sulci. Not only was there a superabundance of fluid in the arachnoid spaces, but the brain itself appeared soggy and wet. . . . The muscle, galea, and scalp were closed without a drain.



Figs. 3 and 4.—Photographs taken three weeks after right subtemporal decompression for the cerebral œdema of nephritis. Note the curvilinear scalp incision and partial shaving of the head (Fig. 3), which allowed of subsequent concealment of the operative field with the patient's hair (Fig. 4).

During the operation the systolic blood pressure fell from 300 to 210 mm. Hg.

The wound healed by primary union. Her general condition seemed considerably improved, although for some days she remained noisy, excited, and hysterical. Her headaches subsided; there was no further nausea and vomiting; her stupor rapidly disappeared; the usual lethargic state, even on her best days, was replaced by a normal mental activity.

October 28, *Ophthalmoscopic Examination* (Bordley). "Rendered difficult owing to the now contracted pupils, but it is evident that the swelling is distinctly less than before the operation. The situation of the disks can be clearly made out."

November 4. The patient was transferred again to the medical side. On this date the following note (Bordley) was made upon the eye-grounds: "The swelling of the disks and retinæ, approximately the same on the two sides, does not exceed 1 D. The retinal tissue is much clearer. In the right eye there are several long, thin hemorrhages; in the left eye there are three wide, flat ones. The disks are covered with exudates and new connective tissue. There is only a faint trace of the physiological cup, which is filled in. The four principal veins can be distinctly made out in both eyes, and there is a suspicion that two arteries in each eye are visible as small, while lines. In the left eye there is the typical star-shaped figure usually attributed to albuminuric retinitis. Throughout each retina there are silvery white patches. Exudates are no longer to be seen. There is a vast and rather unlooked-for improvement in the condition of both eyes."

November 13, *Ophthalmoscopic Examination* (Bordley). "There is a still further decrease in the swelling of both nerves and retinæ; the decrease in the retinæ is so great that it now requires a minus lens to make out the details. (At this examination the existence of myopia became apparent for the first time.) The stellate figures are rapidly disappearing; where the lines which composed them formerly were solid, they now present a beaded and broken appearance; where they formerly were fused, they are now separated by clear retinal tissue showing clumps of pigment. The bloodvessels are much more distinct, but it is still difficult to recognize any arteries. The general condition is much improved."

December 3 (Bordley). "The general retinal condition shows additional improvement in a further subsidence of the swelling in both eyes. While the outlines of the disks cannot as yet be seen, the large exudative mass over them is completely absorbed. The physiological cup can be located by the white mass of tissue within its normal confines. The nephritic white changes and stellate figures are gradually disappearing. The vessels can be distinctly seen entering the cup. The appearance, instead of being that of a snow-white mass, is distinctly red, from the fact that the color of the choroid is becoming discernible. In the left eye there are two or three apparently new hemorrhages and some small ones which follow the radiating direction of the Müllerian fibers in the macular region (to be accounted for possibly by an acute upset with headache and vomiting which was apparently occasioned by the excitement of attending, somewhat against her will, a medical clinic on the preceding day). The vessels, including the arteries, can now all be seen with great distinctness; even the margins of the disks are discernible. The perivascular spaces are filled in with white connective tissue."

After the operation and during the patient's two weeks' residence in the surgical ward she improved greatly, although the condition of the urine remained unaltered and her blood pressure continued at almost as high a level as before. Due doubtless to the abeyance of pressure symptoms, her appetite improved; she gained considerably in weight; her color and general appearance changed markedly for the better. She was up and about the ward for a month before her discharge, having only one upset of any kind and that—a day's headache—was apparently attributable, as mentioned above, to the excitement of attending an ampitheatre clinic.

The protrusion at the seat of the bone defect, which had been considerable for a few weeks after the operation, gradually subsided, and the temporal muscle lay flat from then until the time of her discharge. Her general condition was so much improved that we were led to discuss the advisability of renal decapsulation, in the hope of improving the vascular condition of the kidneys, but the patient felt so well that she begged to return home, at least for the holiday season; and rather against advice, in consideration of her unfavorable home surroundings, she was permitted to do so.

The physical examination made just before her departure showed practically nothing new. The cardiac condition remained the same, showing the increased area of dulness with a ringing aortic second, although no murmurs were heard on this day of discharge. The lungs were clear; there was no œdema. The blood pressure registered 200. She was free from headache and nausea—in fact, better than she had been at any time since her admission.

On December 26, two weeks after her discharge, she was readmitted to Dr. Barker's service in a semiconscious state. Nothing definite could be learned of her movements during the interval, nor of the length of time she had been ill.

The examination on re-admission showed a marked and exceedingly tense protrusion at the seat of the decompression, which had been flat at the time of her discharge. She could be aroused so as to answer a few simple questions, but would sink again into a lethargic state. There was an extraordinary degree of subcutaneous œdema, confined to the tissues of her face and neck.

Her eyes were protruding, and the œdematous lids could be only partially closed; the right palpebral cleft was wider than the left. The œdema involved the conjunctivæ, and there were redundant folds about the cornea. The right pupil was smaller than the left; they both reacted sluggishly to light. When aroused the patient was unable to see objects, although there apparently was some light perception. There was no squint; tests of ocular movements were unsatisfactory. The tongue protruded in the mid-line; it was covered with a heavy white coat. The jaw was not deflected. She could not be persuaded to move her facial muscles, so that the presence or absence of palsy could not be made out.

The examination of the chest revealed practically the same condition recorded at the time of her previous admission, although the respiratory sounds were now everywhere accompanied by medium fine moist rales. There was no ascites or evidence of accumulation of fluid elsewhere; no œdema of the extremities. Reflexes of the upper extremities were not obtained. There was an active patellar response on the left; on the right it was barely obtainable. A flexor response (?) occurred to plantar stimulation on both sides.

During the next three or four days the œdema of the face increased greatly; it was more marked on the left side than on the right, supposedly due to the position of her head, for it was held persistently turned toward the left; the eyes became completely closed. On lumbar puncture a small amount of cerebrospinal fluid was obtained: it escaped slowly—a drop in four or five seconds. The needle was left inserted until an ounce was withrawn. There was no improvement or other alteration in her condition as a result of this measure.

Her stupor gradually deepened, and after the first few days it was impossible to arouse her. There was at no time any slowing of the pulse. The temperature, which was normal on admission, gradually rose to 101° and over. There was incontinence of urine. It is recorded in the notes that she could "grasp with her right hand;" that she could "move her left arm;" that there was "no paralysis of the arms." An attempt to examine the eyes on two successive occasions was unavailing, even after the administration of atropine, owing partly to the patient's restlessness and partly to the extreme œdema of the lids and conjunctivæ.

Her blood examination showed: Red blood corpuscles, 3,896,000; white blood corpuscles, 10,600; hemoglobin, 75 per cent. The differential count was within normal limits.

By January 3 she was unable to swallow, and on the following day Cheyne-Stokes respiration appeared in company with a weak and irregular pulse.

On January 6 a second lumbar puncture found fluid under great tension; an ounce and a half was removed, with a resultant softening of the tense protrusion at the seat of the decompression. No change in her general condition followed the withdrawal of this fluid.

On January 7 there was evidence of pulmonary involvement, with dulness in the axilla and over the right back. Coarse, moist rales were heard everywhere; the respiratory sounds in the lower right axilla were distant.

She died on the evening of January 8, two weeks after her admission, there being practically no alteration in the clinical picture which has been given.

Reading between the lines of her second clinical history, the copious notes of which have been but briefly abstracted here, it is apparent that the chief attention of the clinicians was drawn toward her cardiovascular and renal state, in the belief that her condition was due to a return of uremic symptoms, little suspicion being held that an apoplectic stroke had occurred. In all likelihood the presence of a cerebral extravasation was masked owing to the cerebral distention which was permitted at the seat of her former decompressive operation; and it is improbable that with an intact skull she could have lingered for so long a time in the presence of such a large hemorrhage as was found at autopsy.

AUTOPSY, January 9, 1908, 11.30 A.M. Dr. Winternitz.

ANATOMICAL DIAGNOSIS. Chronic diffuse nephritis (small, granular kidney); cerebral hemorrhage; arteriosclerosis; hypertrophy of the heart; chronic aortic and mitral endocarditis; decubitus ulcers; chronic splenic tumor; hyaline degeneration of arterioles of spleen; choked disk with retinal degenerative changes; chronic tuberculous broncholymphadenitis; acute bronchopneumonia (bilateral).

The *body* is that of a white woman, 155 cm. in length, considerably emaciated; rigor mortis is not marked. Livor mortis is considerable in the dependent portions. . . . The conjunctivæ are markedly bulged out and wrinkled. Over the lower portion of each cornea there is an opacity about 5 mm. in width. . . . In the left temporal region there is a defect, . . . the site of an old craniotomy. Over the sacrum there is a large decubitus ulcer, . . . also a second small ulcer over the left great trochanter. . . . The subcutaneous fat is of a deep yellow color and small in amount. . . . The peritoneal surfaces seem everywhere smooth and glistening. There is no excess of fluid. . . . The liver extends 8 cm. below the ensiform cartilage. . . . There are a few adhesions about the spleen and liver. The pleural cavities contain about 400 c.c. of bloody fluid; they are free from adhesions. . . . The pericardial surfaces are everywhere smooth and glistening; the sac contains no excess of fluid. The *heart* is somewhat enlarged; weighs 320 grams. The epicardial surfaces are everywhere smooth and glistening. The coronary vessels are prominent and tortuous; yellow plaques can be seen through their walls. . . . The tricuspid valve, especially its middle cusp, is somewhat thickened. . . . but seems competent. . . . The mitral orifice admits two fingers; the valve is slightly thickened and opaque, especially at its line of closure and attachment of the chordæ tendinæ. The left ventricle is markedly hypertrophied and contracted. The wall averages 2 cm., and in places measures over 24 mm. The musculature is very pale; . . . here and there it is flecked by irregular, slightly yellowish areas. The aortic valves are somewhat thickened, and the line of closure . . . is slightly granular in appearance. The base of the aorta as well as the anterior cusp of the mitral valve contain numerous yellowish subintimal thickenings. The coronary arteries are tortuous and thickened, showing everywhere on their walls heavy yellowish, opaque placques. The *left lung* . . . is of a mottled color, . . . more congested at the posterior border, while the lower lobe is of a deep purple. . . . The bronchi contain some frothy fluid. . . . On section . . . here and there small dark elevated reddish brown spots which are firmer than the surrounding tissue and stand out as very slightly granular areas. . . . The lowest dependent portion of the lower lobe is collapsed, non-air-containing and of a deep reddish brown color. The *right lung* is slightly more voluminous than the left. There is a large lymph gland at the hilum, the centre of which contains a broken down, cheesy mass about 1 cm. in diameter. This gland rests directly upon the bronchus. . . . Otherwise, this lung resembles the left in every respect. The *spleen* is separated with some difficulty from the parietal wall. It measures 12.5 by 5.5 by 3.5 cm.; weighs 100 grams. The capsule . . . is slightly thickened throughout. It is fairly soft. . . . The Malpighian corpuscles are made out with considerable difficulty, and there seems to be a slight increase in fibrous tissue. The *stomach* contains . . . about 200 c.c. of rather cloudy green fluid. The mucosa is mottled everywhere with small, reddish brown areas. . . . The biliary and pancreatic ducts are patent. The *pancreatic* . . . lobulation is rather distinct, but not excessively prominent. . . . The islands of Langerhans are visible. The *liver* . . . weighs 1320 grams. . . . On section the lobulation is rather indistinct. The liver substance is very pale. There are small, opaque, yellowish areas surrounding the hepatic veins.

The *kidneys* together weigh 120 grams. The *left kidney* is small; measures 9.5 by 5 by 3.5 cm. The capsule, which is somewhat thickened, strips fairly readily, leaving an irregular granular surface. The renal surface is mottled, pale, yellowish gray in color, with the superficial stellate veins . . . prominent. On section the substance of the organ is very pale. The cortex, . . . pinker in color than the pyramids, is noticeably thin and irregular; in some places measuring 4 mm., in other places barely measuring 2 mm. The striations are much obscured; where they are made out they are irregular and tortuous. The glomeruli are not seen. The pyramids are paler than the cortex and surrounding them there is a more opaque, yellowish area. The vessels are slightly engorged, but in no place are hemorrhages to be made out. The *right kidney* measures 9 by 4.5 by 3.5 cm. It is very similar to the left. The pyramids are slightly pinker in color and the striations are obscured.

The *adrenal* cortex is somewhat opaque, yellowish, and there is a central semitransparent gray area in the medulla. The *bladder, rectum, tubes, ovaries, uterus,* and *intestines* are normal. The *aorta* contains numerous yellowish, subintimal thickenings, especially around the orifices of the intercostal and splanchnic vessels. The *thyroid* is slightly enlarged, of a transparent yellowish color. On section the colloid seems to be in excess and the alveoli enlarged.

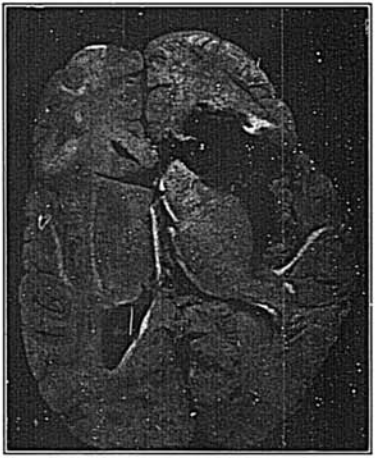


FIG. 5.—Showing the situation of the apoplectic clot.

. . . The *brain* is apparently enlarged; œdematous; convolutions flattened. . . . There is a 5 cm. circular protrusion at the seat of the cranial defect where dura is missing. The protrusion involves chiefly the outer aspect of the right temporal lobe. The arachnoid is not adherent to the overlying temporal muscle. The floor of the third ventricle bulges markedly, and on pressure considerable fluid escapes when it is incised. On incising the right hemisphere to open the lateral ventricle of that side; . . . a large clot is found, which lies lateral to and above the basal nuclei (Fig. 5). . . . This extends laterally to within 4 mm. of the surface of the brain. . . . The outline of this clot is irregular, . . . and it is placed somewhat more anteriorly than the usual capsular clot. The clot is for the most part. . . . of a homogeneous, deep, brownish black color, but that immediately next to the brain tissue is of a lighter shade and is more friable. The area of hemorrhage measures approximately 10 by 4 cm. The left lateral ventricle is slightly dilated. . . . The ependyma is normal.

Histology. Heart: The muscle fibres are definitely enlarged, as are also their nuclei. . . . *Lungs:* . . . The alveolar walls are congested, and in some places the alveoli contain serum, in others small numbers of red and white blood cells with few endothelial cells and small amounts of fibrin. The consolidation is not very marked. *Bronchial lymph glands:* Contain numerous softened and necrotic eosin-staining masses of tissue which are fairly well encapsulated by a wall of fibrous tissue. In one of these some calcareous material is found. *Thyroid:* An increase of colloid; acini appear somewhat enlarged, and epithelium in places is possibly higher than normal; no involution figures of epithelium are to be observed. *Spleen:* Capsule and trabeculæ slightly thickened. . . . The Malpighian bodies are normal, but their arteries are thickened and show an eosin-staining, glassy-looking media. The walls of the venous spaces show a definite increase in fibrous tissue. *Liver:* The cells surrounding the hepatic vein are somewhat shrunken and contain a considerable amount of greenish brown pigment. . . . *Kidneys:* Capsule is thickened. Coarse bands of connective tissue run in everywhere from the surface, giving the organ a mottled appearance. There are areas rich in fibrous tissue, where the tubules, as well as the glomeruli, are either distorted or entirely obliterated, or . . . where the epithelium has been desquamated, alternating with areas where the tubules are dilated with granular detritus or with homogeneous staining casts or cellular debris. The epithelium of the tubules is low, granular, and shows varying amounts of fatty change. The glomeruli, as a rule, are fairly well preserved, in some places showing thickening of their capillary walls. The vessels, especially of the sclerosed areas, show considerable hyaline degeneration. . . . *Brain:* The cerebral tissue at the edge of the extravasation shows a ragged border lined with well-preserved red blood cells. All through this area in the surrounding brain tissue, phagocytes heavily laden with a golden pigment are seen. . . . Organization is beginning to take place in certain areas. . . .

Examination of the Eyes. The optic nerve with the entire eyeball were preserved in 4 per cent. formalin for a few days, after which windows were cut in the globe to allow of further penetration of hardening fluid. Sections through the centre of lens and disk show, on gross examination, 0.6 mm. swelling of the disk, the physiological cup being filled in with new tissue (Fig. 6). The vaginal sheath of the nerve is dilated and the subdural space nearly obliterated by

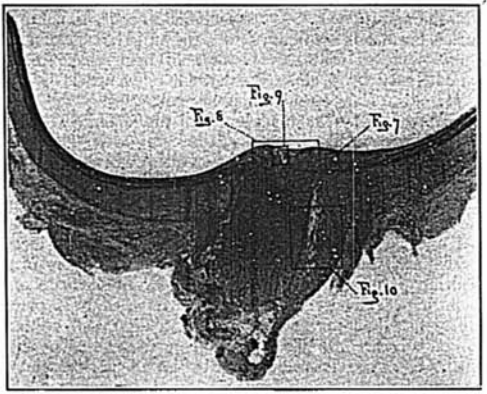


FIG. 6.—Microphotograph (6 diameters) of a section through the centre of the swollen disk and a portion of the optic nerve. The squares indicate areas from which subsequent figures have been taken.

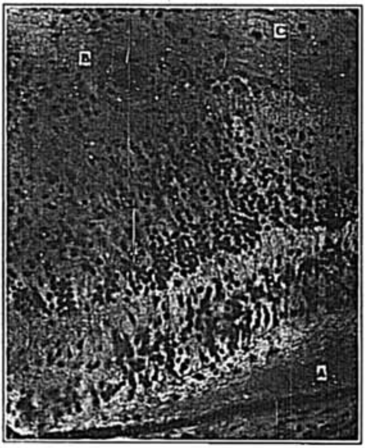


FIG. 7.—Showing *A*, retinal detachment; *B*, vessel containing hyaline thrombus; *C*, thickened nerve-fiber layer (200 diameters, reduced ½).

new tissue formation. The retinal separation is shown in several places by small, blister-like elevations (Fig. 7).

Microscopically there is loss of surface epithelium with round-cell infiltration in a small area of the right cornea; the anterior chamber is filled with leukocytes. In this eye there is hypopion keratitis. The other structures, exclusive of retina, choroid, and optic nerve, are normal. The following changes are present in each eye in practically equal degree:

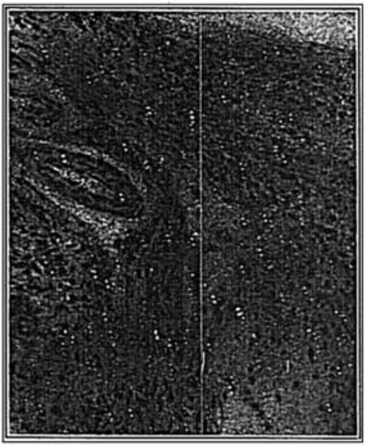


FIG. 8.—Showing the edge of the physiological cup filled with new tissue, subintimal thickening of vessels; vacuolated spaces, etc. (200 diameters, reduced ½).

Retina. Fairly large spaces in both the nuclear layers and the layer of Henle are filled with a fine meshwork, which appears to be of fibrin, judging from its affinity for eosin. There is marked proliferation of the neuroglia cells under the hyaloid membrane, giving the surface of the retina a wavy appearance. One large and several small retinal separations (Fig. 7) are visible, the spaces being filled with an albuminous coagulum. The multipolar ganglion cells are well preserved. The cytoplasm of some of the cells is shrunken; in others it is vacuolated, giving a swollen, transparent appearance to the cells. The nuclei show little evidence of degenerative change. The retinal vessels show distinct endothelial and subendothelial proliferation; in the perivascular lymph spaces, especially of the larger vessels, there is an increase in the connective

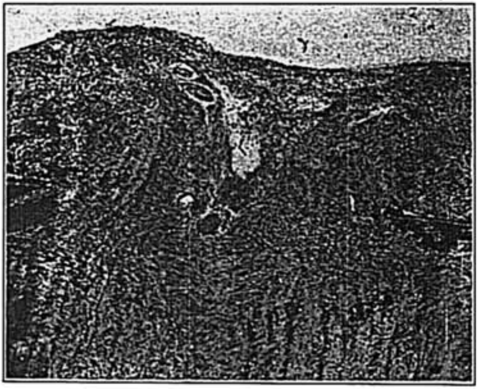


FIG. 9.—Showing the cup filled with new tissue; loss of the transverse marking of the lamina cribrosa, etc. (30 diameters).

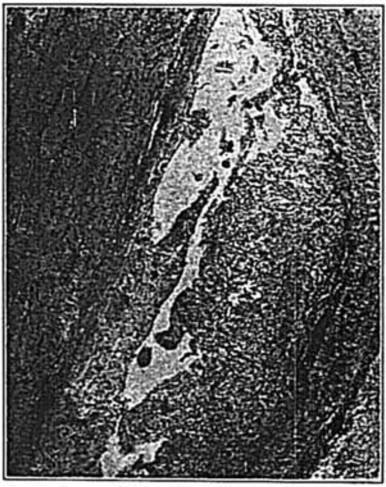


FIG. 10.—Showing the ampullated portion of the vaginal sheath largely obliterated by the formation of new tissue (40 diameters).

tissue elements and infiltration with lymphoid cells. In many of the vessels hyaline thrombi can be seen (Fig. 7). These alterations are also present in the vessels of the papilla (Fig. 8). The nerve fiber layer is about double its normal thickness, and gives clear evidence of marked œdema.

Optic Nerve. The papilla is swollen and extends well above the retina. The physiological cup is filled with new connective tissue (Fig. 9), which passes across the surface of the papilla and extends to the retina immediately adjacent. This new tissue shows only slight metamorphosis, the cellular elements still being abundant. The nerve fibers are tortuous and separated; in many of the interstices between them serous and fibrinous exudates can be made out, although, as a rule, the spaces are clear. Throughout the papilla can be seen thrombosed capillaries and hemorrhages both large and small. In places the hemorrhages have broken through and appear on the surface of the disk. The transverse markings of the lamina cribrosa are lost. The body of the nerve is swollen, the nerve bundles are separated, and there is some lymphoid infiltration and neuroglial proliferation. The dural sheath is much thickened. The ampulla is distended and filled with new tissue (Fig. 10). There is a fairly widespread distribution of hematogeneous pigment throughout the nerve head.

Choroid. There is every evidence of congestion with œdema. Many of the vessels are greatly distended and others show endothelial proliferation. There is no evidence of inflammatory reaction.

COMMENT. The nature of the cerebral lesion in nephritis, which is responsible for the symptom-complex of uremia, has long been a subject of conjecture; and conjecture in regard to pathological processes breeds disagreement. The view most widely accepted attributes the symptoms to some toxic disturbance arising either in a disordered metabolism or in the retention of some products of normal metabolism which fail of elimination through the diseased renal epithelium.[1] A similar disagreement exists in regard to the agency which produces in nephritis the well-recognized alterations in the eye-grounds, they being more commonly attributed, as the term albuminuric neuroretinitis would indicate, also to a disturbance—an inflammation in this case—of toxic origin.

In addition to the objective changes visible with the ophthalmoscope, there often occur in chronic renal disease, even in the absence of a state justifying the term uremia, a number of subjective symptoms directly comparable to those seen in conditions known to be associated with an increase of intracranial tension—more particularly headache, nausea or vomiting, drowsiness, and vertigo—not to mention the rhythmicities of pulse and respiration, often of a Cheyne-Stokes type, which may be present in the later stages.[3] In consequence of this, the differentiation between nephritis with cerebral symptoms and an intracranial abscess, tumor, hemorrhage or serous meningitis co-existent with albuminuria, often presents great difficulties; and this is the more so since in the former conditon definite focal symptoms, such as aphasia, temporary amaurosis (independent of the changes in the fundus oculi), hemiplegia, localized paralyses, Jacksonian epilepsy, and the like, may arise.[4]

---

[1] On the toxic theory, it has always been difficult to explain the absence of uremic symptoms in cases of complete suppression of urine in which a large excess of urea and other excrementitious products occurs in the blood.

It seems to have been first suggested by Traube (1861) that these symptoms in nephritis, so characteristic of an increase of cerebral tension, might actually be due to a cerebral œdema—a mechanical process, therefore—rather than to any autotoxic disturbance; this abandoned hypothesis has of late years been seriously reconsidered by Byrom Bramwell, A. E. Russell,[5] and others. Local œdemas, furthermore, most easily account for the focal palsies of cerebral origin which not infrequently occur in cases of advanced renal disease—palsies which remain unexplained in the absence of any lesion demonstrable after death. Doubtless for the reason that œdema is an evanescent condition, effectually masked by the usual methods of hardening tissues, these views in regard to the causation of symptoms have been the outcome of clinical and experimental studies rather than of postmortem examination of the tissues concerned.

Any swelling of the brain, be it a general or a circumscribed process, necessarily leads to compression symptoms, the eye-grounds furnishing at an early stage an objective and sensitive index of the process. This is even more true of œdema than of states of increased cerebral pressure due to an encroachment on the intracranial space by a solid growth or an abscess.

Thus neuroretinal changes characterize a number of conditions associated with cerebral œdema—notably they are seen after cranial traumatism which has led to cerebral contusion; after thrombosis or embolism in which the area of softening swells from inbibition of fluid; they also accompany the "wet brain" in acute alcoholism and the so-called serous meningitis of febrile and other states; they are not uncommonly seen in cases of cerebral arteriosclerosis. Indeed, in many cases of tumor, areas of œdema due to circulatory disturbances may occur in parts remote from the growth, giving false localizing signs (Collier); and it is presumable that, in the absence of tumor, local œdemas from one cause or another may sometimes occur which so closely simulate the picture of a rapidly enlarging growth as to make the processes clinically indistinguishable—the so-called "pseudotumor" of Nonne[6] comprising a group of supposed tumor cases in which there has been either a spontaneous recovery or in which the symptoms have been permanently relieved by decompression or, in case of death without operation, in which no lesion whatever has been disclosed at autopsy.

---

[3] The high pressure pulse in these cases of renal disease with cerebral symptoms need not of course be primarily attributable to the acute increase of intracranial pressure, although some have attempted to associate the conditions. In this patient under discussion, for example, the decompression had only a transient and slight effect in lowering the high blood-pressure; whereas, for comparison, in cases of intracranial tension due to hemorrhage an immediate and permanent fall in pressure occurs after a successful decompression.

[4] Riesman: Uremic Aphasia, Jour. Amer. Med. Assoc., October 11, 1902, p. 883.

[5] The Pathology of Uremia, West London Med. Jour., January, 1907.

The swelling of the brain from œdema, particularly after traumatism and in serous meningitis, is associated with an excess of fluid under increased tension in the cerebrospinal spaces, and in favorable cases a lumbar puncture, or repeated punctures, may suffice to tide over the period of pronounced compression symptoms. Seemingly the same condition exists in uremia, and of late years, since attention has been drawn to this matter, there have been a number of recorded instances in which uremic coma and convulsions have been markedly relieved after the withdrawal of fluid by a lumbar puncture.[7]

We have been given the privilege in Dr. Barker's service during the past two or three years of observing a number of patients with renal disease, suffering from headache and vomiting, in whom the usual so-called albuminuric retinitis was present. In a number of instances a continuous examination of the eye-grounds has been made coincident with the withdrawal of the subarachnoid fluid from the lumbar region. Striking changes, particularly in the vascular condition—chiefly shown as a straightening of the veins and narrowing of their caliber—have been demonstrable under these circumstances, and, not uncommonly, for the time being there has been a distinct lessening of the headache and nausea. In a number of cases, particularly when the process has not been of long standing, a measurable subsidence of the swelling has promptly occurred. These changes, as might be expected, are usually transient, and in the course of a few hours, or, in exceptional cases, of a few days, with the re-accumulation of fluid it is usual for the preëxisting condition to become reëstablished.[8]

---

[6] Fälle von Symptomenkomplex "Tumor cerebri." (Pseudotumor cerebri.) Deut. Zeit. f. Nervenheilk., 1904, vol. xxvii, p. 169; also Neurolog. Centralbl., 1905, vol. xxiv, p. 1077. Cf. also H. H. Hoppe: Brain Tumor Symptom Complex with Termination in Recovery. Jour. of Nerv. and Ment. Dis., February, 1907.

[7] Purves Stewart: Significance of the Cerebrospinal Fluid. Edinburgh Med. Jour., May, 1906, p. 439. Also A. E. Russell: The Pathology of Uremia. West London Med. Jour., January, 1907; Scherb: Revue Neurologique, vol. x, No. 1, p. 19, Willson: Jour. of the Amer. Med. Assoc., 1904, etc.

[8] When the swelling of the disk and retina is due to edema alone, in the absence of the infiltration which occurs in consequence of stasis of long standing, the subsidence of the swelling may be very rapid. In experimentally induced choked disk, brought about by allowing fluid to enter the subdural space under tension, the swelling may appear after a few minutes of compression, and will as rapidly subside when the pressure has been withdrawn.

Similar observations, in accord with those of others, have been made by us on a few cases of eclampsia in Dr. Williams' service. In one of these patients in whom the symptoms had been acutely acquired, a prompt subsidence of the choked disk ("neuro-retinitis") occurred after the puncture, with early disappearance of all of the so-called albuminuric changes, except the hemorrhages, which slowly absorbed. In this connection Slemmons' studies[9] on "eclampsia without convulsions" are interesting, and go to show that symptoms of cerebral pressure of a degree not sufficient to cause convulsions may coincide with albuminuria in pregnancy, and may even be fatal, with a postmortem disclosure of the characteristic lesions of eclampsia. Slemmons concludes that the clinical observations which he has made strongly indicate a high tension within the cranium. Unfortunately in his cases no ophthalmoscopic examinations were made.

With these observations in mind, and in the light of our favorable experience with decompression for the cerebral œdema following fractures of the cranial base, we were led to suggest decompression in the patient whose case has been recorded, on the assumption that the uremic symptoms were attributable to cerebral œdema, and the changes in the eye-grounds, at least in part, to the cerebrospinal fluid stasis in the optic sheath produced by this same intracranial disturbance. The outlook for the patient, as less radical measures had failed, was most forlorn, and the attempt had its justification in the subsequent marked improvement which enabled her to leave the hospital in a few weeks, at least subjectively well.

So far as we are aware this is the first case of a deliberate surgical intervention in a case of uremia on the view of its being a pressure phenomenon. It, however, is not the first recorded case of operation. In his *Clinical Studies*, Byrom Bramwell[10] relates the history of a patient who, some years ago (1893), was admitted to the Edinburgh Royal Infirmary, suffering from headache, vomiting, optic neuritis, giddiness, and convulsions—symptoms which had arisen during the course of a recent pregnancy. A differential diagnosis lay between cerebral tumor, cerebral abscess, and uremia, and inasmuch as the symptoms presented certain unilateral features and an examination disclosed a discharging otitis media, the preferential diagnosis was cerebral abscess. An operation by Mr. Cotterill, exposing the left temperosphenoidal lobe, showed an increase of pressure, but failed to disclose an abscess. One of three exploratory punctures was followed by the evacuation of an abundance of cerebrospinal fluid, evidently from the ventricle. "The patient made an uninterrupted recovery, the headache and vomiting speedily subsided, there was no return of the epileptiform attacks, the optic neuritis immediately declined, and in the course of a few days entirely disappeared." Bramwell goes on to say that this case and its remarkable improvement suggests the advisability of trephining for the relief of increased intracranial pressure in such cases of uremia as have failed to be relieved by the ordinary remedies.

---

[9] Eclampsia Without Convulsions. Johns Hopkins Hospital Bulletin, 1907, xviii, p. 448.

[10] Clinical Lecture on Uremia and its Treatment. Clinical Studies, 1906, N. S., v, p. 1.

Experiences of this kind naturally serve to support Traube's hypothesis that the symptoms of uremia are produced by cerebral œdema, although Traube's explanation of the process—namely, that increased arterial pressure due to hydremic plethora and hypertrophy of the left ventricle, is the cause of the œdema, this, in turn, leading to vascular anemia through pressure—will perhaps not be accepted by all.[11] Gowers,[12] for example, pointed out that, although the cardiac hypertrophy and the retinal lesion commonly correspond in the time of their appearance, the latter is, nevertheless, occasionally found in the absence of the former.

The difficulty at times of distinguishing between cases of brain tumor or abscess and cases of nephritis with cerebral symptoms must have been experienced by many. A number of illustrations of this have come under our observation—of patients who have been admitted to the surgical wards with a diagnosis of neoplasm, extensive renal disease having subsequently been found; and, on the other hand, of patients who have died after a prolonged treatment for nephritis, in whom autopsy has disclosed an intracranial growth. It may be added furthermore that we have frequently seen in tumor cases an ophthalmoscopic picture the counterpart of what is supposed to characterize the retinal changes of nephritis, and, vice versa, the typical picture of the choked disk of tumor in cases of nephritis.

It must be granted that the symptoms characterizing uremia, and what interests us even more, the alterations of the eye-grounds in nephritis, can be attributed in part, if not wholly, to the mechanical effects of increased intracranial pressure resulting from cerebral œdema. It is a quibble to refer the œdema back to some toxic agency. In a sense, of course, all œdemas are remotely due to toxic disturbances; for example, the swelling of an extremity (Stauungs-hyperämie) which results from the application of a tourniquet is really toxic, although the œdema has been primarily brought about by a mechanical agency. The discomfort of the swollen foot in the tight boot would be lessened under these circumstances by slicing the leather, just as are the discomforts of the tense brain by opening the dura. In regard to uremia, therefore, to be conservative, we may at least say that the symptoms are elicited by œdema resulting from some toxic agency, and are not, as is commonly supposed, due to the direct effect on the cerebral tissues of the toxic agent alone.

We believe, from our clinical and experimental studies of choked disk, that the œdema of the retina itself is due in large part, even in these cases of nephritis, to a backing of cerebrospinal fluid under increased tension into the investing meningeal sheath of the optic nerve. In this patient's case the rapid and pronounced subsidence of the swelling, in spite of its long duration, of its unusually high grade, and of the accompanying round-cell infiltration and organization which we were able to demonstrate histologically, would seem to add further confirmation to this view.

---

[11] Senator's discussion in Nothnagel's System, "Diseases of the Kidneys," American edition, 1905, p. 102.

[12] Medical Ophthalmoscopy, 1890, 3d ed., p., 213,

Although the chief reason for presenting this individual history was the opportunity of discussing the matter already alluded to, there are some other points which may deserve mention—among them, the terminal event in this unfortunate girl's life. As cited by Byrom Bramwell, it is Rose Bradford's view that uremia occurs more frequently in the young and as a symptom of the "small white" rather than of the "small red granular" kidney. In his Goulstonian lectures[13] he says: "In the great majority of cases of acute uremia in which coma is developed the insensibility is preceded by a convulsive seizure or series of epileptiform attacks. But cases are occasionally met with in which sudden coma due to uremia occurs without any preceding convulsion. These cases are very rare and are apt to give rise to great difficulty in diagnosis, for suddenly or rapidly developed coma occurring in the course of disease of the kidney . . . is highly suggestive of cerebral hemorrhage—much more suggestive of cerebral hemorrhage than of uremia." Comment has already been made, in the relation of the patient's history, upon the failure clinically to recognize the fact that she had suffered from an apoplectic stroke, the difficulties of this perhaps having been enhanced by the comparatively slow march of her symptoms owing to the cerebral protrusion which was made possible by the former decompression operation—a protrusion which obviated the acute pressure symptoms which under other circumstances would, in all probability, have been more promptly fatal.

Conclusion. In view of the marked improvement after cerebral decompression, this case adds further evidence in support of Traube's hypothesis (favored by Bramwell, Russell, and others) that the cerebral symptoms present in the so-called state of uremia are largely due to pressure from œdema of the cerebral tissue.

It goes to show, furthermore, that the condition of so-called albuminuric neuroretinitis is, in large part at least, a local œdema of mechanical origin.

The case suggests the propriety of permanent decompression in selected instances of renal disease when medical measures or lumbar puncture have failed to relieve existing cerebral (uremic) symptoms, or when blindness is threatened owing to rapidly advancing degenerative changes of the neuroretinal tissues.

---

[13] Rose Bradford: Observations on the Pathology of the Kidneys. The Lancet, April 2, 1898, p. 916.